Skeletal and Muscular Systems

Guide for Reading

After you read the following sections, you will be able to

2–1 The Skeletal System

- List the functions of each part of the skeletal system.
- Describe the characteristics and structure of bone.
- Describe three types of movable joints.

2–2 The Muscular System

- Classify the three types of muscle tissues.
- Explain how muscles cause movement.

2–3 Injuries to the Skeletal and Muscular Systems

- List the three most common injuries to the skeletal and muscular systems.

Slowly, the young man climbs up the ladder toward the top of the circus tent. The crowd grows quiet. You feel your heart beginning to beat faster. You tilt your head back. Your eyes follow the man in the glistening costume. As he grabs the trapeze, the muscles in his arms bulge. Suddenly, he leaps and is flying through space. Then he lets go of the trapeze and does a somersault in midair . . . once, twice, three times. You gasp and then gaze in disbelief as, incredibly, the man does another somersault—a quadruple! It has never been done before!

How, you wonder, has the trapeze artist been able to perform such a daring feat? Part of the answer lies in the hundreds of hours he has spent training and practicing. And part of the answer lies in the dedication he has brought to his work. But certainly he could never have performed this spectacular act if it were not for his finely coordinated body. Working together with many of his other organs, the trapeze artist's bones and muscles have made the "impossible" happen. In the pages that follow, you will discover how your skeletal and muscular systems work for you—making the ordinary to the almost impossible possible.

Journal *Activity*

You and Your World Perform one type of movement with each of the following parts of your body: finger, wrist, arm, and neck. In your journal, describe the motion of each body part. What allows you to move these body parts? How is each motion different?

A trapeze artist performs a daring feat—a quadruple somersault!

Guide for Reading

Focus on these questions as you read.

- *What are the five functions of the skeletal system?*
- *What is the structure of bone?*

2–1 The Skeletal System

The skeletal system is the body's living framework. This complicated structure contains more than 200 **bones**—actually, about 206. The bones are held together by groups of stringy connective tissues called **ligaments.** Another group of connective tissues called **tendons** attach bones to muscles. Together, the bones, ligaments, and tendons make up most of the skeletal system.

Functions of the Skeletal System

The skeletal system has five important functions: It provides shape and support, allows movement, protects tissues and organs, stores certain materials, and produces blood cells. The first of these important functions—giving shape and support to the body—should be pretty clear to you. Imagine that you did not have a skeletal system. What would you look like? A formless mass? A blob of jelly? The answer is yes to both descriptions! In fact, if the skeletal system did not perform this vital role, it would be meaningless to consider any of its other functions.

The skeletal system helps the body move. Almost all your bones are attached to muscles. As the muscles contract (shorten), they pull on the bones,

ACTIVITY DOING

Bones as Levers

Using books in the library, find out about the three classes of levers. How do bones act as levers? On posterboard, draw one class of levers. Next to the drawing, draw an example of the bones that act like that lever. In the drawing, label the effort, load, and fulcrum. At the bottom of the posterboard, define effort, load, and fulcrum.

What are the two other classes of levers? Give an example for each of these levers in the body.

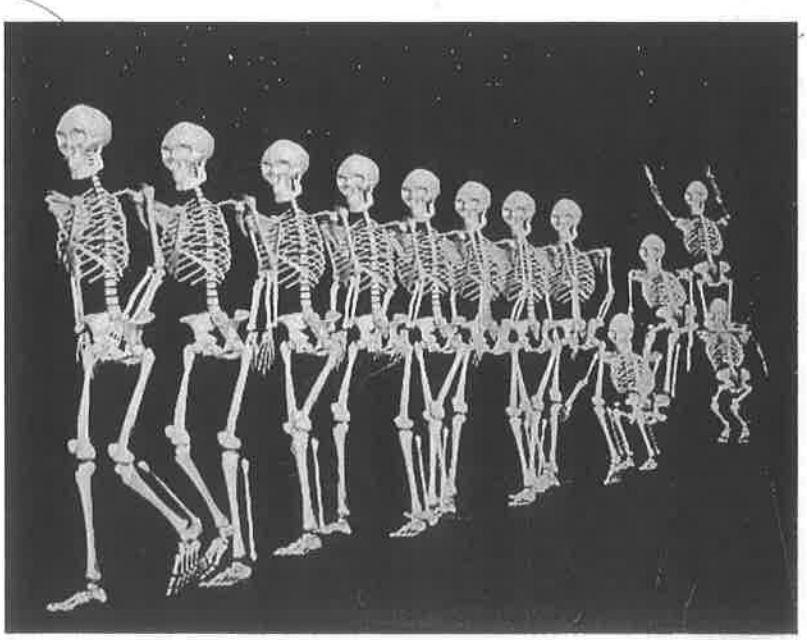


Figure 2–1 *As a result of computer graphics, the jumping and walking movements of a human skeleton take on a ghostly appearance. What type of connective tissue holds the bones of the skeleton together?*

causing the bones to move. By working together, the actions of the bones and muscles enable you to walk, sit, stand, and do a somersault.

Bones protect the tissues and organs of your body. If you move your fingers along the center of your back, you will feel your backbone, or vertebral column. Your backbone protects your spinal cord, which is the message "cable" between the brain and other body parts. As you may recall from Chapter 1, the spinal cord is made up of nerve tissue. Nerve tissue is extremely soft and delicate and, therefore, easily damaged. So you can see why it is important that the spinal cord is protected from injury.

Bones are storage areas for certain substances. Some of these substances give bones their stiffness. Others play a role in blood clotting, nerve function, and muscle activity. If the levels of these substances in the blood should fall below their normal ranges, the body will begin to remove them from where they are stored in the bones.

The long bones in your body (such as those in the arms and legs) produce many blood cells. One type of blood cell carries oxygen. Another type destroys harmful bacteria.

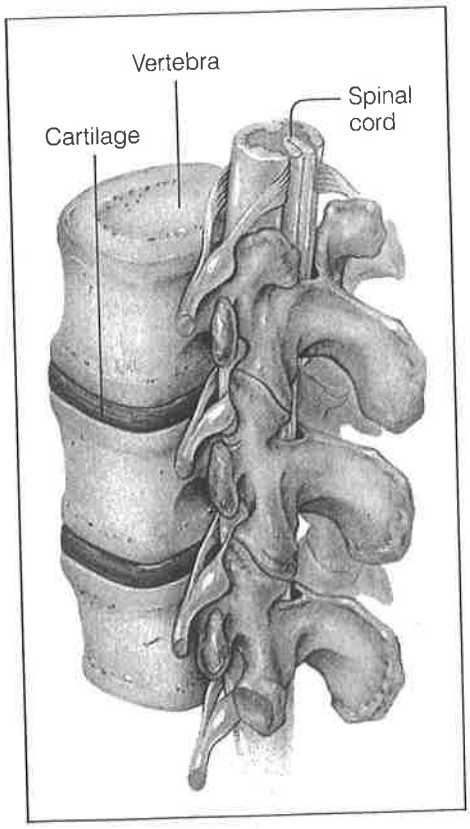


Figure 2–2 *The vertebral column consists of a series of small bones stacked one on top of the other. Together, these bones protect the delicate spinal cord and also form a strong support for the body. What are the individual bones of the vertebral column called?*

Parts of the Skeleton

Suppose you were asked to make a life-size model of the human skeleton. Where would you start? You might begin by thinking of the human skeleton as consisting of two parts. The first part covers the area that runs from the top of your head and down your body in a straight line to your hips. This part includes the skull, the ribs, the breastbone, and the vertebral column. The vertebral column contains 26 bones, which are called vertebrae (VER-tuh-bray; singular: vertebra, VER-tuh-bruh).

The second part of the skeletal system includes the bones of the arms, legs, hands, feet, hips, and shoulders. There is a total of 126 bones in this part of the skeletal system.

Figure 2–3 *Unlike humans, the king crab has a hard external skeleton. What are some advantages of having an internal skeleton?*

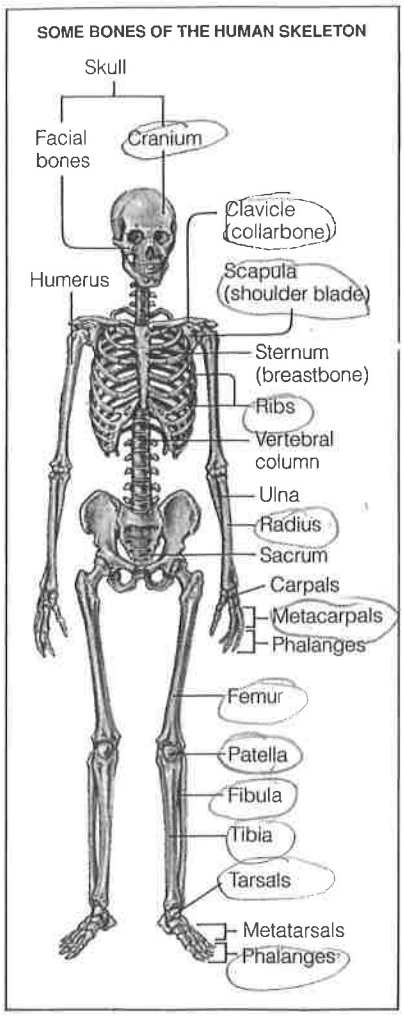


Figure 2–4 *There are approximately 206 bones in the human skeletal system. What is another name for the collarbone?*

Development of Bones

Many bones are formed from a type of connective tissue called **cartilage** (KAHRT-'l-ihj). Cartilage is a very hard, stiff jellylike material. Although cartilage is strong enough to support weight, it is also flexible enough to be bent and twisted. You can prove this to yourself by moving your nose back and forth and by flapping your ears. The tip of your nose and your ears are made of cartilage.

Many bones in the skeleton of a newborn baby are composed almost entirely of cartilage. The process of replacing cartilage with bone starts about seven months before birth and is not completed until a person reaches the age of about 25 years. At this time, a person "stops growing." However, some forming and reforming of bone still occurs even in adulthood, primarily where bone is under a great deal of stress.

Although most of your body's cartilage will eventually be replaced by bone, there are a few areas where the cartilage will remain unchanged, such as in the knee, ankle, and elbow. These areas are usually found where bone meets bone. Here the cartilage has two jobs. One job is to cushion the bones against sudden jolts, such as those that occur when you jump or run. The other job is to provide a slippery surface for the bones so that they can move without rubbing against one another. Because cartilage is three times more slippery than ice, it is the ideal material for this task.

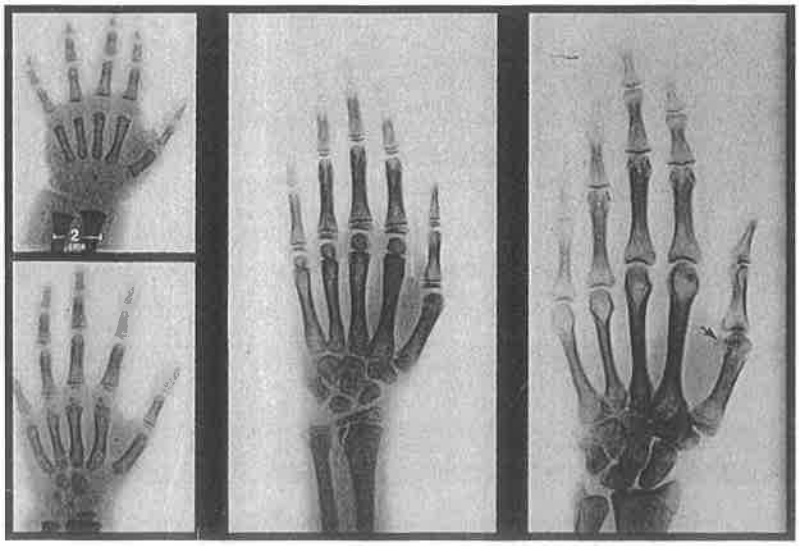


Figure 2–5 *X-rays of the hands of a 2-year-old (top left) and a 3-year-old (bottom left) show that the cartilage in the wrist has not yet been replaced by bone. In the X-ray of a 14-year-old's hand (center), the replacement of cartilage by bone is almost complete, as it is in the hand of a 60-year-old (right). What type of tissue is cartilage?*

Structure of Bones

Bone is not only one of the toughest materials in the body, it is also one of the lightest. You may be surprised to learn that the 206 bones of your skeletal system make up barely 14 percent of your body's mass! Because of bone's strength, you may have thought of bone as nonliving. On the contrary, bones are alive. They contain living tissue—nerves, bone-forming cells, and blood vessels.

Bones, however, are similar in some ways to such nonliving things as rocks. Can you think of a few reasons why? Two obvious similarities are hardness and strength. Both bones and rocks owe their hardness and strength to chemical substances called minerals. Rocks contain a wide variety of minerals; bones are made up mainly of mineral compounds that contain the elements calcium and phosphorus. As you may already know, dairy products, such as milk and cheese, are good sources of calcium and phosphorus. So next time someone suggests that you drink lots of milk "to keep your bones strong and healthy," you will know why this suggestion makes sense.

Let's take a close look at the longest bone in the body to see what it (and other bones) is made of. This bone, called the femur (FEE-mer), links your hip to your knee. Probably the most obvious part of this bone is its long shaft, or column. The shaft, which is shaped something like a hollow cylinder, contains compact bone. Compact bone is dense and similar in texture to ivory. Within the shaft of a long bone are hollow cavities, or spaces. Inside these

ACTIVITY

DISCOVERING

Examining a Bone

1. Obtain a turkey or chicken leg bone.

2. Clean all the meat off the bone. Using a knife, cut off one end of the leg bone. **CAUTION:** *Be careful when using a knife.* Examine the bone carefully.

What is the name of this bone? Describe what the bone looks like inside and out. Identify as many parts of the bone as you can. What is this bone called in the human skeleton?

■ The bones of birds are very light. Why do you think this is so?

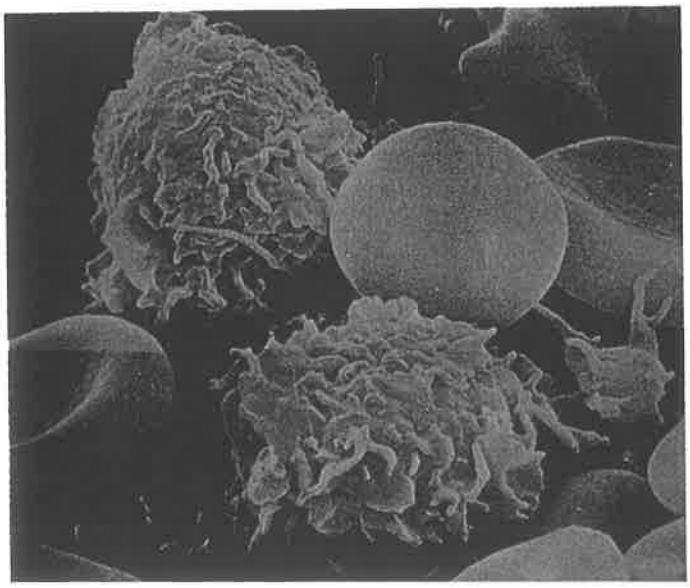
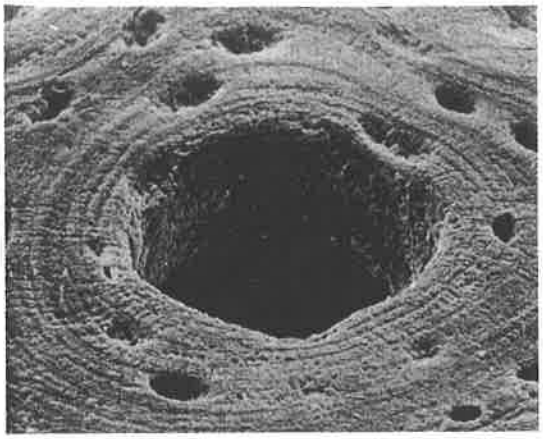


Figure 2–6 *The red marrow of bones such as the skull and ribs produces the body's red blood cells and white blood cells. As seen through an electron microscope, red blood cells are beret-shaped structures and white bloods cells are furry-looking structures. What does yellow marrow contain?*



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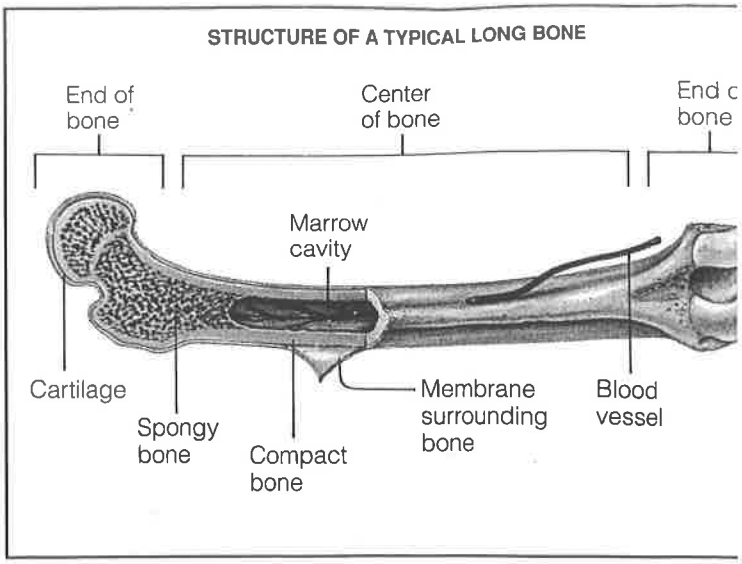


Figure 2–7 *As the diagram illustrates, the most obvious feature of a long bone is its long shaft, or center, which contains dense, compact bone. Running through compact bone is a system of canals that bring materials to the living bone cells. One such canal is seen in the center of the photograph. What materials are carried through the canals?*

ACTIVITY DISCOVERING

Are Joints Necessary?

1. With masking tape, tape the thumb and fingers of the hand that you write with together. Make sure that you cannot move or bend the fingers.

2. Now try these activities with the taped-up hand: button a shirt, tie a shoelace, turn the pages of a book, pick up a pencil, open a door, turn on a radio, and pick up a coin.

How would you describe the ease with which you did these tasks? Why do you think this is the case?

■ Explain why it is important to have joints in your fingers.

cavities is a soft material called yellow **marrow.** Yellow marrow contains fat and blood vessels. Another type of marrow called red marrow produces the body's blood cells. Red marrow is found in the cavities of such places as the skull, ribs, breastbone, and vertebral column.

Surrounding the shaft of the femur is a tough membrane that contains bone-forming cells and blood vessels. This membrane aids in repairing injuries to the bone and also supplies food and oxygen to the bone's living tissue. Muscles are attached to this membrane's surface. At each end of the shaft is an enlarged knob. The knobs are made of a type of bone called spongy bone. Spongy bone is not soft and spongy, as its name implies, but is actually quite strong. Because spongy bone resembles the supporting girders of a bridge, its presence at the ends of long bones adds strength to bone without adding mass. Figure 2–7 shows these basic parts of a bone.

Running through the bone is a system of pipelike canals that bring food and oxygen to the living bone cells. These canals also contain nerves. The nerves send messages through the canals to living parts of the bone.

Skeletal Joints

Imagine that you are pitching your first baseball game of the season. The catcher signals you to throw a fast ball. You know that the batter is a powerful hitter, so you shake your head no. The catch

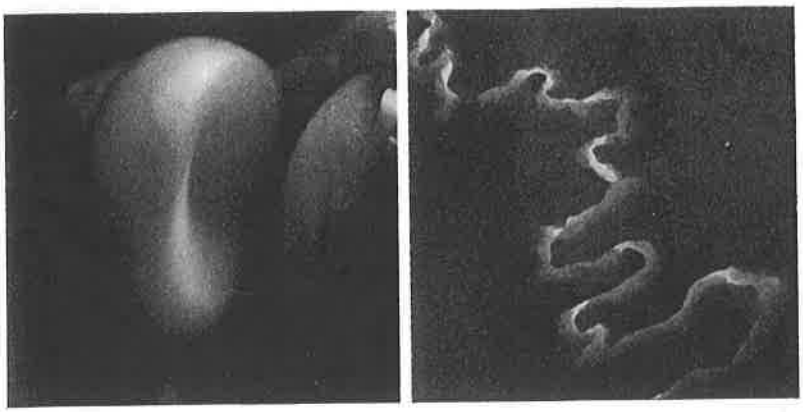


Figure 2–8 *Joints, or places where two bones meet, allow bones to move without damaging each other. The ball-and-socket joint in the shoulder (left) permits the greatest range of movement, whereas the joints in the skull (right) do not move at all. What type of joint is found at the elbow?*

changes the signal to a curve ball. You agree and nod. And then you wind up and send your curve ball sailing over the plate. "Strike one!" the umpire shouts.

You could not make any of these simple movements—shaking and nodding your head or winding up and pitching the ball—if it were not for structures in your skeletal system called **joints.** A joint is any place where two bones come close together. Generally, a joint is responsible for keeping the bones far enough apart so that they do not rub against each other as they move. At the same time, a joint holds the bones in place.

There are several different kinds of joints. Some joints allow the bones they connect to move. Other joints permit little or no movement. Examples of joints that permit no movement are the joints found in the skull. Although these joints permit no movement, they enable the bones in the skull to fuse (join) as you grow. In the pitching example you just read about, the pivot joint, which is located between the first two vertebrae in your neck, enabled you to shake and nod your head in response to the catcher's signals. A pivot joint allows for rotation of one bone around another.

When you wound up to pitch your curve ball, the ball-and-socket joint of your shoulder allowed you to swing your arm in a circle. Ball-and-socket joints, which provide for the circular motion of bones, consist of a bone with a rounded head that fits into the cuplike pocket of another bone. Can you think of

CAREERS

Athletic Trainer

It's the summer of the Olympic Games. You are enjoying the diving competition on television. The divers twist and turn their bodies as they glide through the air to the delight of their audience.

The people who help to prepare athletes for the Olympics or for other competitions are called **athletic trainers**. Athletic trainers instruct athletes on how to strengthen muscles by doing special exercises. They also suggest special diets to keep athletes healthy. Trainers must also know when an injury or a problem requires a doctor's examination.

If you are interested in sports and would enjoy helping athletes do well, you might consider a career as an athletic trainer. To receive more information, write to the National Association for Sport and Physical Education, 1900 Association Drive, Reston, VA 22091.

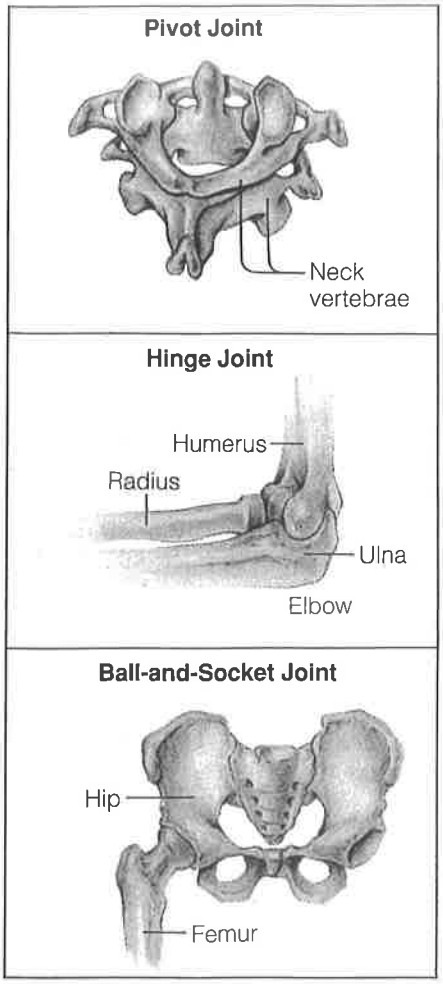
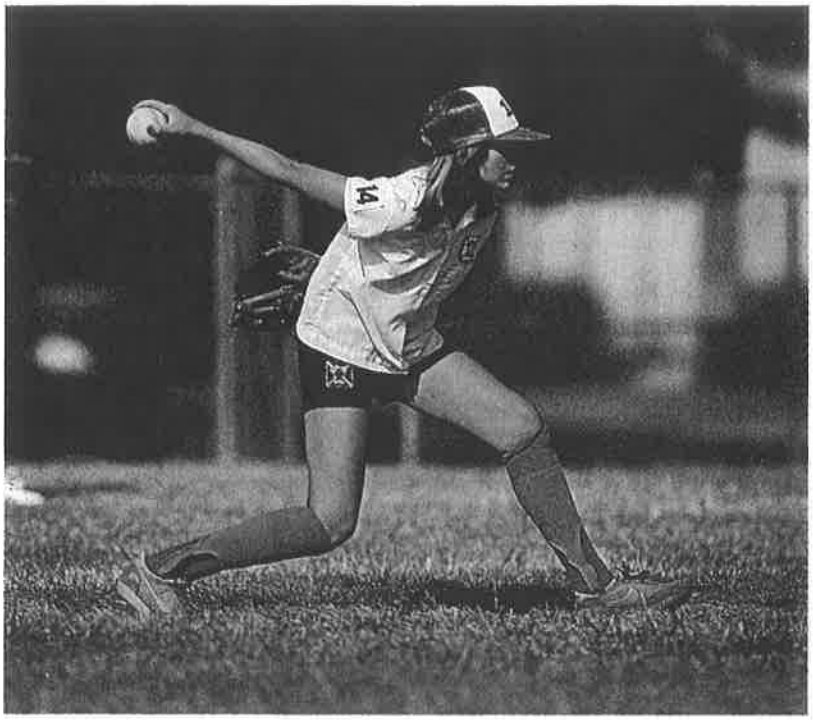


Figure 2–9 *The actions involved in pitching a ball require the use of many types of joints. What movement does the ball-and-socket joint allow for?*



another location in your body where you would find a ball-and-socket joint?

As you moved your arm forward, the bend at your elbow straightened out and you whipped the ball toward the batter. The elbow is a hinge joint. A hinge joint, which is also found at the knee, allows for movement in a forward and backward direction. However, it allows for little movement from side to side. Figure 2–9 shows where the hinge joint and the other joints you just read about are located in the body.

2–1 Section Review

1. What are the five functions of the skeletal system?
2. What is a ligament? A tendon?
3. List three places in the body where cartilage is found.
4. What is marrow?
5. Compare the movements of three types of movable joints.

Critical Thinking—*Relating Facts*

6. Suggest an advantage of having the ribs attached to the breastbone by cartilage.